HISTORIC PROPERTY INVENTORY FORM

State of Washington, Department of Community Development
Office of Archaeology and Historic Preservation
111 21st Avenue Southwest, Post Office Box 48343
Olympia, Washington 98504-8343 (206)753-4011

IDENTIFICATION SECTION

Field Site No. 1706-KER **OAHP No.** **Date Recorded** 6-Apr-98
Site Name Historic Recirculating Test Facilities
Common
Field Recorder Jim Sharpe
Owner's Name U.S. Department of Energy, Richland Operations Office
Address P.O. Box 550
City/State/Zip Code Richland, WA 99352

LOCATION SECTION

Address Building 1706-KER, 100-K Area
City/Town/County/Zip Code Richland/Benton County/99352
Twp 13 **Range** 26 **Section** 32 **I/4 Section** SW **1/4 1/4 Sec** SW, NE
Tax No./Parcel No. **Acreage**
Quadrangle or map name Coyote Rapids, Wash. Quad. 1986
UTM References Zone 11 **Easting** 301390 **Northing** 5169280
Plat/Block/Lot
Supplemental Map(s)

Status
- [x] Survey/Inventory
- [ ] National Register
- [ ] State Register
- [ ] Determined Eligible
- [ ] Determined Not Eligible
- [ ] Other (HABS, HAER, NHL)
- [ ] Local Designation

Photography
Photography Neg. No. (Roll No. & Frame No.) Roll 43 Neg. # 14
View of
Date 6/24/98

Classification [ ] District [ ] Site [x] Building [ ] Structure [ ] Object
District Status [x] NR [ ] SR [ ] LR [ ] INV
Contributing [x] **Non-Contributing** [ ]
District/Thematic Nomination Name Hanford Site Manhattan Project and Cold War Historic District

Description Section
Materials & Features/Structural Types
Building Type Industry
Plan
Structural System
No. of Stories

Roof Type
- [ ] Gable
- [x] Flat
- [ ] Monitor
- [ ] Gambrel
- [ ] Shed
- [ ] Hip
- [ ] Pyramidal
- [ ] Other (specify)

Cladding (exterior Wall Surfaces
- [ ] Log
- [ ] Horizontal Wood Siding
  - [ ] Rustic/Drop
  - [ ] Clapboard
- [ ] Wood Shingle
- [ ] Board and Batten
- [ ] Vertical Board
- [ ] Asbestos/Asphalt
- [ ] Brick
- [ ] Stone
- [ ] Stucco
- [ ] Terra Cotta
- [ ] Concrete/Concrete Block
- [ ] Vinyl/Aluminum Siding
- [x] Metal (specify) Corrugated transite
- [ ] Other (specify)

Roof Material
- [ ] Wood Shingle
- [ ] Wood Shake
- [ ] Composition
- [ ] Slate
- [x] Tar/Built-up
- [ ] Tile
- [ ] Metal (specify)
- [ ] Other (specify)
- [ ] Not visible

Foundation
- [ ] Log
- [ ] Post & Pier
- [ ] Stone
- [ ] Brick
- [ ] Not visible

Concrete
- [ ] Block
- [x] Poured
- [ ] Other (specify)

High Styles/Forms (Check one or more of the following)
- [ ] Greek Revival
- [ ] Gothic Revival
- [ ] Italianate
- [ ] Second Empire
- [ ] Romanesque Revival
- [ ] Stick Style
- [ ] Queen Anne
- [ ] Shingle Style
- [ ] Colonial Revival
- [ ] Beaux Arts/Neoclassical
- [ ] Chicago/Commercial Style
- [ ] American Foursquare
- [ ] Mission Revival
- [ ] Spanish Colonial Revival/Mediterranean
- [ ] Tudor Revival
- [ ] Craftsman/Arts & Crafts
- [ ] Bungalow
- [ ] Prairie Style
- [ ] Art Deco/Art Moderne
- [ ] Rustic Style
- [ ] International Style
- [ ] Northwest Style
- [ ] Commercial Vernacular
- [ ] Residential Vernacular (see below)
- [x] Other (specify) Industrial Vernacular

Integrity (Include detailed description in **Description of Physical Appearance)**

	Intact	Slight	Moderate	Extensive
Changes to plan	x			
Changes to windows				
Changes to original cladding	x			
Changes to interior			X	
Other (specify)				

Vernacular House Types
- [ ] Gable Front
- [ ] Gable Front and Wing
- [ ] Side Gable
- [ ] Cross Gable
- [ ] Pyramidal/Hipped
- [ ] Other (specify)

NARRATIVE SECTION

Study Unit Themes (check one or more of the following)

[ ] Agriculture	[ ] Conservation	[ ] Politics/Government/Law
[ ] Architecture/Landscape Architecture	[ ] Education	[ ] Religion
[ ] Arts	[ ] Entertainment/Recreation	[ ] Science & Engineering
[ ] Commerce	[ ] Ethnic Heritage (specify)	[ ] Social Movements/Organizations
[ ] Communications	[ ] Health/Medicine	[ ] Transportation
[ ] Community Planning/Development	[ ] Manufacturing/Industry	[x] Other (specify) Manhattan Project & Cold War Era
	[ ] Military	[x] **Study Unit Sub-Theme(s)** Reactor Operations, Resea

Statement of Significance

Date of Construction 1952-1955 Architect/Engineer/Builder Kaiser Engineers

[x] In the opinion of the surveyor, this property appears to meet the criteria of the National Register of Historic Places.

[x] In the opinion of the surveyor, this property is located in a potential historic district (National and/or local).

See continuation sheet.

Description of Physical Appearance

See continuation sheet.

Major Bibliographic References

See continuation sheet

Historic Property Inventory From
The 1706-KER Building
Continuation Sheet

Statement of Significance, continued

The 1706-KER Building, also referred to as the Reactor Loop Testing Building and the Recircultaion Test Facility, was designed to provide high purity oxygen free water at the desired pH for the KER in-reactor loops (HW-62911). It is 180 feet west of the 1706-KE Building and adjacent to the 105 KE Reactor. It was designed in 1952 with construction starting in 1954 and completed in 1955. In 1957, piping revisions were made to allow recirculation of organic coolants (HW-56912). The facility operated from 1955 to 1971 (WHC-SP-0331).

The facility was part of the KER-Loop testing system that consisted of four high temperature, high-pressure, through-pile loops located at the KE-Reactor. Each loop was housed in a separate underground cell in the KER Building. In 1957, three of the four loops were put into service. The fourth was put on line a year later. The loops contained trip valves capable of shutting down the reactor if the pressure, temperature, or flow rates of the loops exceeded specifications. The loops were designed to perform experiments to test a variety of possible future reactor fuel elements under prototype conditions of temperature, pressure, coolant flow rates, water quality, and heat generation rate. Each loop consisted of high-pressure zircaloy-2 process tubes that run front to rear in the high flux region of the KE Reactor (HW-6444RD). Charging and discharging of the loops occurred during reactor outages and in general loop operations.

The KER-Building contained a ground floor and basement to house and undertake the testing procedures.

GROUND FLOOR

The main floor is 14 feet high constructed of reinforced concrete. The above ground portion of the building is 80 feet long by 28 feet wide and was constructed of a steel framework covered with corrugated asbestos with an asphalt and gravel roof. The ground floor contained the equipment for ventilation, process controls, switchgear cabinets, battery room, and an area that contained equipment for personnel radiation exposure control.

Ventilation

The ventilation system consisted of two supply and exhaust fans that moved air from clean to contaminated areas. Supply fans were located next to the office space and exhaust fans were located on the north end of the KER tunnel (HW-4500).

BASEMENT

The basement is 14 foot deep by 80 feet long by 65 feet wide. The outer walls of the building were constructed of cement, two feet thick. Inner walls, four feet thick, divide the building into six sections. Four cells, 40 feet by 18 feet each, extended the length of the building. Each basement cell contained two electric driven, high-pressure transfer pumps, a mock-up process tube, heat exchangers, and auxiliary piping. The cells were designed to allow process water to circulate through four process tubes in the KE-Reactor, or through the mock up tubes. In the event of a power failure, the two transfer pumps provided a backup system. The four cells were shielded and housed water treatment, heat exchanger, pumping and remote instrument equipment for each of the four 105-KE in-reactor loops. The loop piping extended about 300 feet through a tunnel to the reactor.

The north side of the basement had an 8-foot wide corridor running the full length of the building between the outer wall and the cells. The south wall contained a similar feature six feet wide that opened into a 14-foot square laboratory. From the north corridor an underground pipe tunnel extended north and east connecting with the 105-KE Building. An underground cell 71 feet long by 7 feet wide was located adjacent to the north corridor. It was designed as an emergency tank storage area.

Twelve thousand cubic yards of materials were removed for construction of the building. Construction materials included 7,950 cubic yards of concrete, 106 tons of reinforcing steel, 25 tons of structural steel, and 3,000 square feet of corrugated siding. The construction and equipment expenses for the Recirculating Test Facility amounted to $549,777 (HW-24800-103).

In 1963, the decontamination and hot maintenance shop were added to the building. The addition was made to the existing building on the north and west sides. The new addition was 54 feet north/south by 22 feet on the north end by 8 feet on the south end.

OPERATIONS OF THE KER FACILITY

The 1706-KER Loops consisted of four high temperature, high pressure, through-pile loops located at the KE-Reactor. The in-reactor loop piping terminated adjacent to the 105-KE Reactor process tube pattern. Two parallel tubing runs connected each loop riser pipe to a specific KER process tube (HW-72996) (Figure 2 and 3). The loops were developed to test a variety of possible future reactor fuel elements under advanced fuel element designs. Tests were performed for prototype conditions for temperature, pressure, coolant flow rate, water quality, reactor flux, and heat generation rate.

The KER-Loop system contained four process tubes designed for service conditions of 2,200-psi pressure and 600 degrees Fahrenheit (HW-72996). Water for the KER facility was obtained from the KE Area filter effluent flumes (HW-62911). Loop-1 was constructed of Schedule 160 carbon steel piping and Loops-2, 3, and 4 were constructed of Schedule 80 type 304 stainless steel piping. Loops 3 and 4 were equipped with Zircaloy-2 process tubes and were later used to irradiate N-Reactor fuel elements. Heat generation rates of the Loops were determined by the capacity of the heat exchangers. The capacity of Loops-1 and 2 was about 2250 kw and about 3800 kw for 3 and 4. Two pumps provided recirculation cooling. If the recirculation cooling capability were lost a _-inch port size dump valve automatically opened to depressurize the loop and establish a once-through cooling of the fuel charge with reactor cooling water (HW-74095).

The flow path of the loops included: 1) reactor tube, 2) rear face and effluent tunnel piping, 3) KER tunnel and north corridor, 4) cell piping, and 5) piping north corridor to front face. Each path is summarized below.

Reactor Face

The reactor tube in each loop was in a large diameter front to rear channel capable of containing pipe up to 2.5 inches outside diameter.

Rear Face and Effluent Tunnel Piping

Special high-pressure nozzles connected the loop piping to the rear face of the reactor. Two one-inch diameter stainless steel tubes that crossed the rear face of the reactor to the near side connected the nozzles. From the near side, the nozzles joined the Y-block by two and one-half inch piping. From the rear face, the piping went to the downcomer area, through the dividing wall into the effluent tunnel, along the ceiling of the effluent tunnel and into the intersecting KER tunnel.

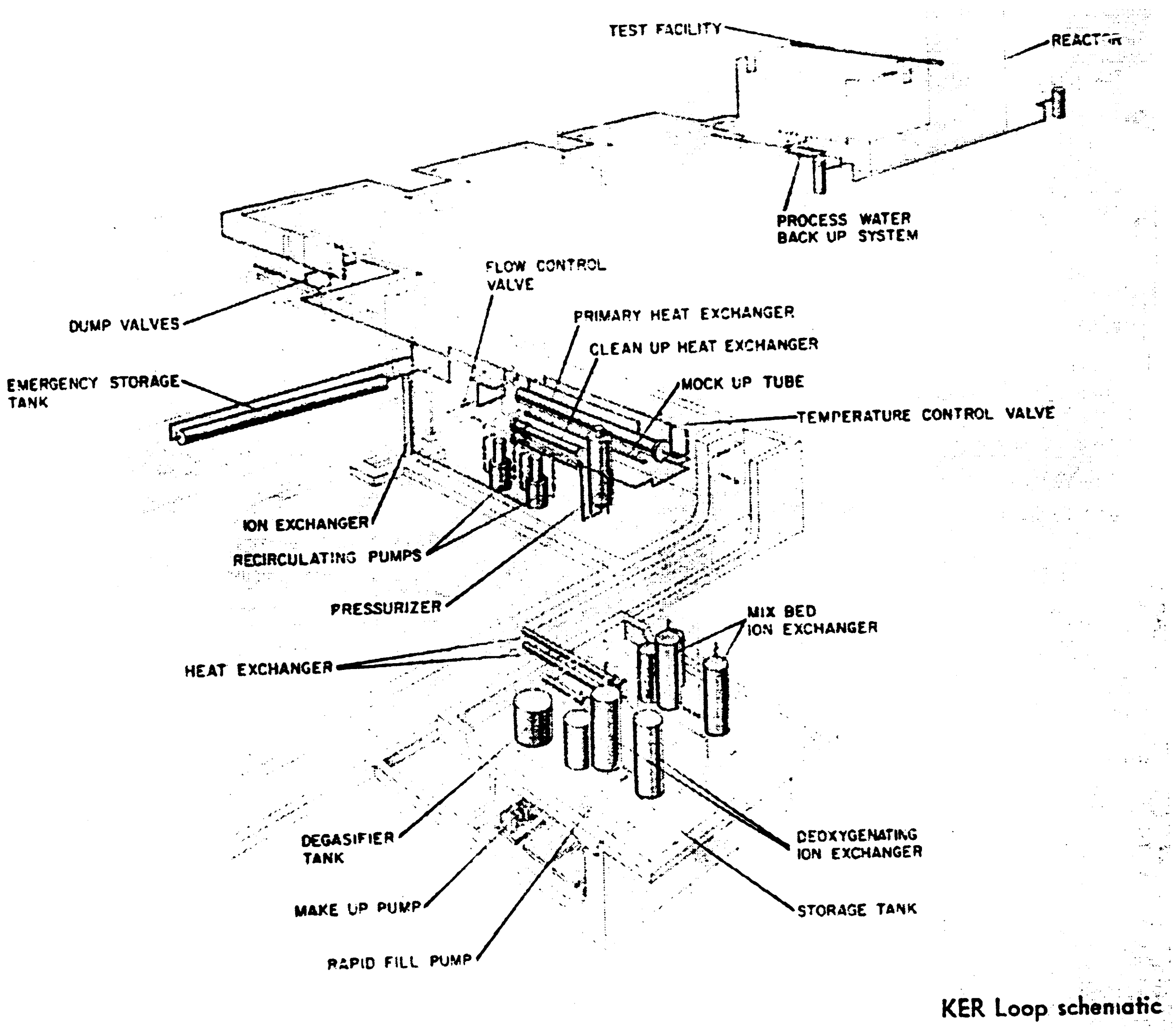
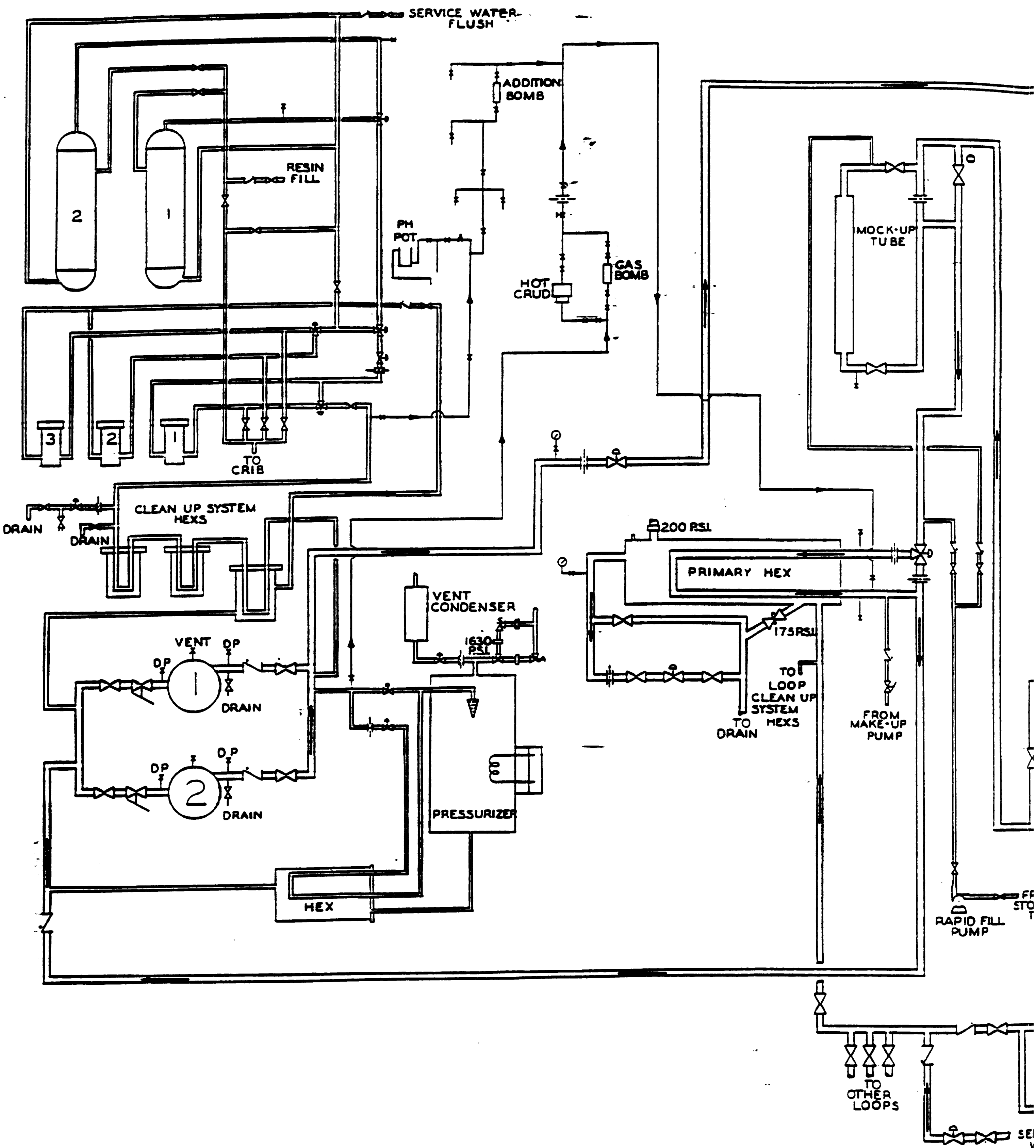


Figure 2: 1706-KER Loop Schematic

UNCLASSIFIED



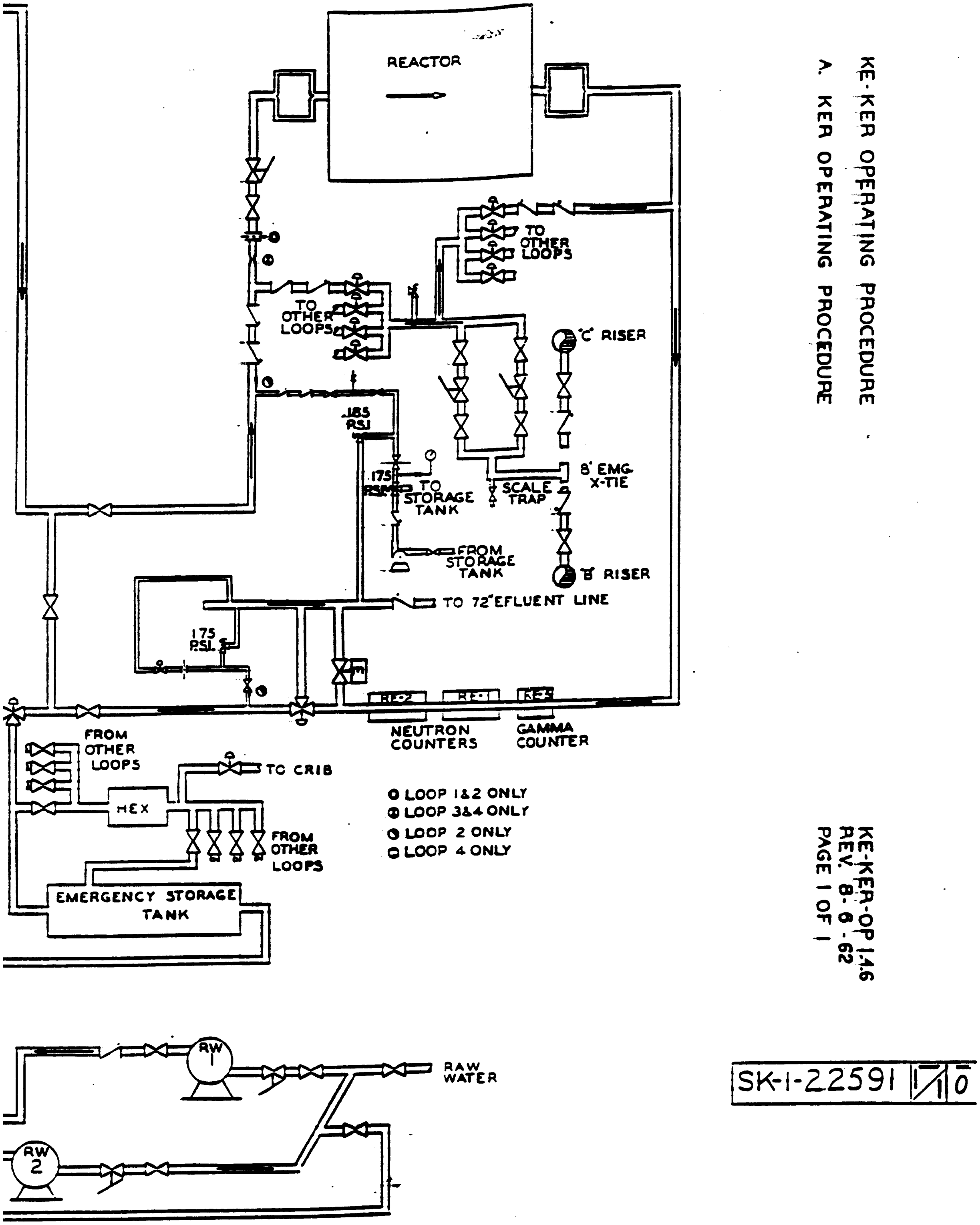


Figure 3: Flow Diagram of the KER Loop

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KER Tunnel and North Corridor

After entering the effluent tunnel the effluent lines went past delayed neutron rupture detectors then on to a dump valve that was connected to the reactor effluent when the loop was not on recircultaion. Piping continued through the tunnel to a strainer and bypass. From the strainer it entered the cell piping.

Cell Piping

The cell piping was designed to obtain out-of-pile information at about the same conditions of temperature, pressure and water quality as the reactor encountered. After leaving the mock-up tubes, the flow traveled to another 3-way valve that would either bypass or route flow through the primary heat exchanger. The heat exchanger controled the system operating temperature. After leaving the heat exchanger the water traveled to the intake of the system pumps where the pressurizer was connected to the system.

Piping-North Corridor to Front Face

Once the pipe entered the north corridor it continued back to the effluent tunnel to a point opposite the Ball 3X Room in the 105 KE Reactor Building. The piping continued into a Y-block where the flow was divided into two one-inch tubing crossheaders and continued across the front face to the nozzle connections (HW-4500).

INSTRUMENTATION

Instrumentation for the KER facility consisted of six primary control systems that included: 1) No.1 Heat Exchanger Outlet Temperature, 2) Degasifier Tank Liquid Level, 3) Degasifier Tank Pressure, 4) No. 2 Heat Exchanger Outlet Temperature, 5) Ion Exchanger Circulation Flow, 6) Storage Tank Liquid Level (HWS-7140). A brief description of the instrumentation system is provided below.

No. 1 Heat Exchanger Outlet Temperature

The system was designed to control the temperature of the water at the inlet to the degasifier spray nozzle. As water temperature increased output air pressure decreased closing the control valve thus decreasing the temperature to its previous setting.

Degasifier Tank Liquid Level

The degasifier controlled the liquid level in the degasifier tank to maintain a constant water-steam interface between the top of the steam coils and the top of the tank.

Degasifier Tank Pressure

The degasifier tank pressure system was mounted on the bottom of the degasifier and was used to heat water for degasifying purposes. Steam formed in the vessel, which allowed it to reach about 5psi. The controller regulated the degasifier pressure by adjusting the quantity of steam that passed through the coil.

No. 2 Heat Exchanger Outlet Temperature

The system was designed to control the heat exchanger outlet temperature to maintain readings that would not damage the resins in the ion exchangers.

Ion Exchanger Circulating Flow

The system controlled the recirculating flow of water through the ion exchangers and the storage tank.

Storage Tank Liquid Level

The system was designed to maintain the storage tank level at desired values and to sound an alarm in the event of low liquid levels in the tank (HWS-7140).

A protection system was installed which was designed to protect the reactor and the loop equipment in the event of improper operation or equipment malfunction. The instrumentation for the system was located in the 1706-KE and the 105-KE buildings and was referred to as the loop shutdown control system. To prevent catastrophic accidents in the event that the loops failed, the KER loops were connected to the reactor safety circuits. If the loops failed, the reactor would automatically shutdown.

EXAMPLES OF OPERATIONAL TESTING

In 1959, Project CGI-839, Modification to Fuel Element Test Facilities was proposed to test NPR size fuel elements in the KER recirculating loops. The objective of the project was "to define the functional and operational requirements of the facilities to be modified and to outline the general descriptions of the proposed equipment" (HW-60747). The project included loop modification, improvements to the process heat exchanger raw water back-up pumps, emergency process back-up water piping, water sampling facilities, new Hot Maintenance and Decontamination Room Building addition, coincidence rupture detection instrumentation, new process tube and nozzle assembly for loops No. 3 and 4, and remote monitoring of process pump instrumentation.

In 1960, a study of the KER Loops was performed to determine the safe operation of the loops and better understand the similarities between the KER Loop and the NPR Loop and the hazard potential. Possible accidents with potentially serious consequences were studied which included:

- fuel element burnout or melting
- opening of a dump valve during recirculation operation
- loss of coolant flow to the loop primary heat exchangers
- coolant loop rupture, including process tube rupture
- loss of one or more recirculation pumps, rupture of a pressurizer rupture disk
- reactor power excursion.

The study concluded that with the exception of a severe coolant loop rupture indicent, the loops did not possess serious hazards potential if changes in the pressurizer piping and operating procedure were made. The change would reduce the hazards potential from bursting of a ruptured disk or a severe pressurizer steam leak. The study went on to state that a single component failure would not scram the reactor in the absence of a scram condition, and would not prevent a scram in the presence of a scram condition (HW-63785).

In 1962, Project CGI-839, initially proposed in 1959, began. The modification to the KER Loops No. 1, 2, 3, and 4 were designed to increase the flow and heat transfer capacity of the Loops to allow in-reactor testing of prototype NPR fuel elements and other fuel elements. The original 1955 code design of Loops No. 1, 2, 3, and 4 were for service conditions of 2,200 psi and 600 F. temperature. In 1959, the code was revised and a lower stress value for the 304 stainless steel materials were accepted. The project required the replacement of Loop piping to meet code requirements (HW-72996).

Additional testing performed in 1962 examined heat transfer calculations to determine the effect of varying system temperature distributions in the process tube wall of the KER Loop No. 1 (HW-74577).

In 1963, the KER Loops were used to conduct tests for fuel, coolant, and corrosion for the N-Reactor program. Modifications were made to Loops 3 and 4 that included N-size Ar-2 process tubes for sufficient pumping and heat dissipation capacity to allow testing of N-fuels. Modifications were also made to Loops 1 and 2 that included the fitting of Zr-2 process tubes of 2.1-inch inner diameter. The small loops were used to test charges of N inner tubes or other elements with an outside diameter of 1.8-inches or less. Loops 1 and 2 allowed for hot water testing conditions for N-inner tubes. The modifications to the Loops provided a testing for N-fuel environmental conditions and hot water testing conditions (HW-77091). The facility was closed in 1971.

CONCLUSION

The 1706-KER Building was a two story facility designed to provide high purity oxygen free water at the desired pH for the KER in-reactor loops. The facility was part of the KER-Loop testing system that consisted of four high temperature, high-pressure through-pile loops located at the KE-Reactor. Each loop was housed in a separate underground cell in the KER Building and were developed to test a variety of possible future reactor fuel elements under advanced fuel element designs. Tests were performed for prototype conditions for temperature, pressure, coolant flow rate, water quality, reactor flux, and heat generation rates.

It is the conclusion of the U.S. Department of Energy that the 1706-KER Building is eligible for inclusion in the National Register of Historic Places under Criterion A as a contributing property within the Hanford Site Manhattan Project and Cold War Era Historic District.

REFERENCES

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